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FROM: Grand Canyon Dam AMP Science Advisors
By L.D. Garrett, Executive Secretary

DATE: July 18, 2003

SUBJECT: GCD AMP Science Advisors Review Comments on the Report; "Status and Management Strategy for Humpback Chub in Grand Canyon

Please find attached a review by the GCD AMP Science Advisors, of the document, "Status and Management Strategy for Humpback Chub in Grand Canyon." This document is provided for potential discussion at the August 13, & 14, AMWG meeting, should that be possible under meeting protocols.

The review report is abbreviated due to time available to the Science Advisors. In this regard, the Science Advisors appreciate being able to implement a 24 month review plan. This step will greatly improve future review capability of the Science Advisor Team.

GRAND CANYON DAM ADAPTIVE MANAGEMENT PROGRAM SCIENCE ADVISOR REVIEW COMMENTS ON THE REPORT; " STATUS AND MANAGEMENT STRATEGY FOR HUMPBACK CHUB IN GRAND CANYON"

BY

GRAND CANYON DAM AMP SCIENCE ADVISORS

JULY 2003

GRAND CANYON DAM ADAPTIVE MANAGEMENT PROGRAM
SCIENCE ADVISOR REVIEW COMMENTS ON THE REPORT;
" STATUS AND MANAGEMENT STRATEGY FOR
HUMPBACK CHUB IN GRAND CANYON"

INTRODUCTION

The Grand Canyon Dam Adaptive Management Program (GCD AMP) Science Advisors are an independent science review group. They are selected through a competitive process, to review scientific and technical adaptive management reports, documents, plans etc., that guide/support the Grand Canyon Dam Adaptive Management Program.

The GCD AMP Science Advisors are pleased to be asked to provide review comment on this report. The requested two month time interval from task notice to report submission, required the advisors to respond with review comments from a subset of our Science Advisor Team. The leadership on this review is by Dr. James Kitchell, noted fish ecologist from University of Wisconsin and Dr. Margaret Palmer, aquatic ecologist, University of Maryland. Review input is also provided by three other team members, and the Executive Secretary for the Advisors.

Timing of the review did not permit development of a "review charge" to the Science Advisors from GCD AMP. As such, the Advisors elected to develop their own charge/approach for the review.

REVIEW PROCEDURE

Currently, procedures used for defining status and management strategies for the humpback chub (HBC) in the Grand Canyon Reach of the Colorado River are being debated by scientists and managers, and possibly questioned by policy makers. In part, this results from two or more HBC "population estimates" being provided by the science community over a 2 year period, that appear "inconsistent." And, based on these information sets, potentially different future management strategies for the HBC population are being debated.

In this project, the Science Advisors selected a review procedure that attempts to address several questions, developed by the Advisors as follows:

- What is the context of the debate over HBC population?

- Do proposed future science/management strategies for the HBC embrace adaptive management, and are they comprehensive in approach?
- Are all facets of all potential impactors effectively presented?
- Are specific program proposals adequate and appropriate to accomplish the goals?
- Is science appropriately invoked?

Following is the Science Advisors brief review comment, as regards the above review questions.

WHAT IS THE CONTEXT OF THE DEBATE OVER THE HBC POPULATION?

The current debate over "State of the HBC Population" is of course critical to adoption of any future adaptive management strategy. And, knowing how the population has been changing and why it is changing is even more critical information to guide future management strategies.

The current debate over "status of populations" is centered around different science approaches. Following is an overview of the "Methods Issue"

The Methods Issue

Two general classes of population estimation are practiced. The "closed population" or "direct estimation" approach uses a sequence of closely timed mark-recapture methods to estimate abundance through the traditional Peterson Method. The key assumption and expectation of this method is that the entire population is sampled in space and over a relatively brief period, i.e., there is no immigration or emigration for the sampled population. This method produces a point estimate of abundance and the associated confidence intervals for that estimate. It is a proven method and can be precise. It is typically a very demanding effort and, therefore, quite expensive. It's debits are that it is of unknown accuracy (given the sampling assumption and its potential bias) it provides estimated abundance at one point in time without using information about previous abundance estimates, and it offers no empirical basis for evaluating trends in abundance, and therefore, offers little insight into possible causes of population change.

The " open population" approach employed by GCMRC staff also uses mark-recapture data to estimate abundance, but employs those data in a more expansive series of analyses as part of a "state space model", or a synthesis that includes many kinds of information, including the existing time series data on catch rates, age structure, size structure and temporal dynamics of vulnerability to sampling. This approach is based on developing separate equations for the true underlying state of the system, testing those with observed data, using statistical methods to estimate probability functions, and adjusting model parameters accordingly.[1] Its debits include the number of parameters that must be estimated. Its merits are based on the multiplicity of information sources employed in creating estimates of abundance, trends in abundance, and likely changes in future abundance. In a simple analogy, the closed population method, based on its assumptions, gives an answer to the question: "How many fish are out there?"

The open population method answers the question based on use of prior estimates, their trends interpreted as realistic measures of change, and offers an empirical basis for estimating future population abundances based on measures of recruitment strength. The method seems to have advantages. Yet, significant controversy exists.

A version of the open method, known as "Supertag", was used to produce the 2001 population estimate of 1100-1200 adult chubs. This low estimate created grave concern about the future of the chub population. Analysis subsequently pursued by GCMRC staff revealed that the information used in the Supertag method did not account for size and age-based short-term changes in vulnerability to the sampling gear. Improving that analysis using a method called "Age-Specific Mark-Recapture" (ASMR), reduced the bias in the Supertag estimation procedure and produced a population estimate of 2000-4000 adult chubs.

In other words, the experts were now saying there were more fish than had been estimated in the recent past. This result evoked another round of controversy. How can the numbers be so very different? The answer is embedded in the differences between methods.

[1] De Valpine, P., and A. Hastings. 2002. Fitting population models, incorporating process noise and observation error. Ecol. Monographs 72. 57-76.

Simply stated, the Little Colorado River spawning aggregation is the focus of most of the sampling, tagging and recapture effort. The Supertag analysis assumed a common pool and a static age distribution of potential adults in its use of mark-recapture data. In other words, the analysis method resembles a closed population method.

In fact, there are important transient dynamics in the appearance of adult fish in the LCR, that cause the Supertag method to be seriously biased and, therefore, produce an underestimate of adult abundance. As is common in fish life histories, the biggest and oldest of chubs enter the LCR to spawn first. They spawn, then some fraction returns to the mainstem and others remain in the LCR. Smaller, younger fish enter the LCR, while the largest adults are still there. When large adults are most abundant in the LCR, small adults are underrepresented in the sampling gear (hoop nets), presumably because of social interactions that keep them separated from habitats occupied by larger adults. The sequence (and consequent sampling bias) is repeated through time until the smallest and youngest of mature chubs have spawned. The sequence starts at different times each year and extends for variable durations. Sampling trips are planned based on the calendar, not on the sequence of spring events that evoke migration into the LCR and spawning behavior. The initiation of migration and spawning can vary by weeks to months.

In other words, a full picture of each year's total spawning population is likely to have been the result of luck and to occur only rarely. Fisheries biologists are aware of these kinds of effects, which is why they are insistent about stating the assumptions of the sampling method. This is an important component of assessing uncertainty.

One of the ways to deal with uncertainty is to look for answers through use of additional, alternative analytical methods. The ASMR method provides independent ways to evaluate the Supertag method. That revealed the bias of the latter, and the basis for the differences in estimated abundance.

Authors of population estimates assert that demanding "the number" is equivalent to demanding that a stock broker produce accurate and precise predictions for a specific investment plan. That won't happen, that shouldn't happen. Final, absolute answers aren't likely in either case and, demanding these answer may be unrealistic.

Representatives of the Denver Fish and Wildlife Service Office advocate a protocol based on the closed population model, which is the preferred method in Upper

Basin work (i.e, Yampa, Green and Upper Colorado Rivers). Scientists at GCMRC advocate the "open model" approach.

The ASMR modeling approach appears to be the superior method, because it gives both a means for estimating chub abundance and insights about trends derived from a synthesis of alternative measures. The ASMR approach seems to offer the best of modern stock assessment methods. It is the most comprehensive and affordable method available at present and should be the basis for future work by GCMRC. The Science Advisors agree with the last paragraph of the Report: "Stay the present course of experimental actions using reasoned responses and treatments to inform future decisions."

IS THE PLAN TRULY COMPREHENSIVE IN APPROACH AND IS THE ADAPTIVE MANAGEMENT PROCESS PROPERLY INVOKED?

The plan is directed at several goals: 4.1) expanding the range of spawning and rearing of HBC by increasing the suitability of the mainstem; 4.2) increase survival and recruitment; 4.3) reducing the risk of catastrophic events

The plan is broad in scope and the proposed actions appear appropriate to the goals. The plan under 4.3 to reduce risk of catastrophic events is extremely important and well grounded in science. Expanding (spatially) the population should be a central objective of a HBC management plan for the Grand Canyon and thus the committee's focus on this is to be commended.

ARE ALL FACETS OF ALL POTENTIAL IMPACTORS EFFECTIVELY PRESENTED?

The report correctly identifies critical impacts to the chub; i.e., temperature, flow, predation, parasites, and hazardous risks; however, the report falls short in considering possible interactive effects of the risks (and their management). Specifically, focused attention needs to be put into a proposal for assessing the interactive effects of various risks and management options in an ecosystems modeling framework. Given the urgency of the present concerns, the model would be centered around the HBC, but once it is developed, it should become a more generic tool that can be used to design adaptive management experiments, alter the course of plans as data are gathered and fed into the model, and to forecast effects of future management options. A scientific synthesis of the

multiple, interacting factors is a serious deficiency in the current science plan as is pointed out in a report in preparation by the SA on the TCD.

A discussion of two individual factors that are not adequately addressed in the present plan and should receive attention follows:. 1) Potential role of food limitation (due to competition with other consumers) in the decline in HBC. At present, there is inadequate information on what the HBC eat and the extent to which their decline may be related to a precipitous decline of allochthonous inputs post Glen Canyon Dam construction. 2) Importance of turbidity in HBC survival and recruitment. The plan does explicitly mention the turbidity issue, but does not propose experiments to test the hypothesis that recruitment may increase significantly if turbidity levels were enhanced in the mainstem. We are told that project 6 would test the effects of increasing turbidity but it is not clear "on what". Such an experiment could also be tied to the issue of allochthonous inputs, since historically high turbidity must have been associated with higher levels of suspended organic matter than are currently present in the river.

ARE THE SPECIFIC PROPOSALS ADEQUATE AND NECESSARY TO ACCOMPLISH THE GOALS SET FORTH IN SECTIONS 4.1, 4.2, AND 4.3? IS SCIENCE APPROPRIATELY INVOKED?

Monitoring plans are associated with most proposed actions so that responses (e.g., of fish populations, parasites, etc) to the actions proposed can be measured and presumably the management plan be adjusted accordingly.

Concerns and comments related to the specific 21 project proposals we received with the report include:

It is not clear how **projects 1, 4** and **19** link to project **3**. Number 3 looks to be in progress and is excellent; it should continue; however, new projects should not be added piece meal. All the genetics work and stocking feasibility should be coordinated and put into one proposal to ensure they are complimentary and maximize the amount of information per research dollar (even if separate components must be contracted out).

There is not enough scientific support to justify **project 2**; fish should not be removed until it is clear that is a unique genetic stock exits.

There is not enough scientific evidence to justify **project 5**. This seems very high

risk given the low numbers of fish. Other measures (e.g., nonnative removals) seem much more prudent at this time.

Projects 6, 7, 8 should move forward in planning, however, we are not presently supplied with enough information to fully evaluate the science associated with each. We would need to consider these within the long term research plan (experimental design). Also, it is essential that the implementation of 6 be done with sufficient funds to ensure tight communication between the scientists and dam operations staff and that rapid changes in dam operations can be made based upon monitoring results.

For **Project 8**, the details are totally lacking. This is quite an inadequate explanation of a potentially very important project. (see above).

Project 9 – Tasks 1 and 2 (in the form of a workshop) are well justified and should occur prior to making a decision on the additional tasks.

Project 10 – 12 are in progress and should be continued as they are scientifically sound and prudent at this time.

Projects 13 and 14 are important, clearly outlined, and should move forward if funds are available.

Project 15 is not well formulated scientifically at present. Levels of parasitism should be monitored, but a clear science plan of what to do with that data to inform management needs to be in place. The field monitoring and lab data should be used in a modeling framework (population dynamics in the system context) that can be used to forecast growth of the parasite population and its relative impacts on the HBC (relative to other factors such as predation).

Project 16 seems to be a confusing proposal. The goals and justification are not clearly articulated and it is unclear how this fits in with GCD AMP and the GCMRC science plan.

Project 17 has embedded within it a potentially very important task that could contribute greatly to a sound scientific management plan for HBC. Namely, in paragraph 3 under the study methods, the use of sonic tags for data on fish movement are mentioned. The feasibility of this should be explored immediately.

Projects 18, 19, 20 are sound and should move forward.